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EVALUATION OF TREE FAILURES IN YOSEMITE NATIONAL PARK

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ABSTRACT

This evaluation discusses tree failures and the hazardous tree program at Yosemite National Park. Tree failures due to root disease are continuing in the Park, but at a lower rate than before the Park's hazard control program. Most of the trees which recently failed bore no signs to indicate that they were prone to fail. Root disease is still causing many failures, but wind and shallow soils are becoming increasingly important as the cause of tree failure where pine stands have been opened up by root disease or bark beetles. Some possible new techniques of identifying infected trees are discussed, as are new treatment actions such as target relocation, buffer strip cutting, and seasonal closures.

The National Park Service (NPS), Western Regional Office requested that Forest Pest Management (FPM), Region 5, provide them with a re-evaluation of the root disease - tree failure problem in Yosemite Valley, Yosemite National Park. On March 27, 28, and 29 Bruce Roettgering, John Pronos, and Dick Smith, from the FPM Staff, met with Tom Gavin and Francis Jaycock, from the NPS Western Regional Office, and Lorne West from Yosemite National Park, to observe, evaluate, and discuss this root disease - tree failure problem. The NPS was particularly concerned about the high cost of controlling hazardous tree situations and the occasional, unpredictable occurrence of single and group tree failures.

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History

Tree mortality and failure caused by Fomes annosus root disease has been recognized as a problem in Yosemite Valley since the early 1960's. In 1971 the Park Superintendent requested that FPM conduct an evaluation of the problem. In response, the National Park Service, the University of California, and FPM of the Forest Service formed a cooperative study group to assess and evaluate the annosus root disease problem and its probable effects, and to develop management alternatives to reduce or eliminate the problem. The results and findings of this work were made available to the Park in the mid-1970's as they became available. A formal report - "An Evaluation of Fomes annosus in Yosemite National Park", Report 78-2, Forest Insect and Disease Management, Region 5 - was presented to Yosemite National Park in 1978.

The eleven-page report stated that there are 105 confirmed F. annosus root disease centers in 17 developed areas scattered throughout the length of Yosemite Valley. By 1975 an estimated 1,100 trees had died in these centers and an additional 1300 trees were predicted to die within the next ten years. Numerous trees in and around these centers had failed, and in falling had damaged property and injured and killed visitors and/or employees. The report predicted that without treatment the root disease-caused tree mortality and failure problem would worsen as the root disease spread, enlarging the centers, and as new centers became established. The report also stated that high winds will increase tree failure and damage as the root disease centers enlarge, open the stands, and expose trees to new and greater wind stresses.

Another report by the same cooperating agencies entitled "Determining Early Failure of Root Diseased Incense-cedar in Yosemite Valley" displayed the correlations between a cedar's crown condition and probable amount of root decay in the root system. This gave the Park recreation managers a means of identifying cedars with probable root decay, and of estimating the amounts of decay and probability of tree failure.

Since obtaining these and other reports, the Park has conducted a vigorous and effective hazardous tree reduction program, aimed at providing for public safety and reducing financial losses associated with tree failures and their damages. In 1983 FPM provided Yosemite National Park with an economic analysis of the Park's hazard tree control program which stated that the program had a present net value of $4 million and a benefit/cost ratio of 50 to 1. This confirmed that economically this is a very advantageous program to support and maintain.

Current Situation

This past winter a large number of trees failed during a severe storm. These falling trees killed one person, did considerable damage to property and cost a great deal to clean up. Within the past few years the Park has experienced a disturbing number of failing trees and associated damages. It is apparent that the hazardous tree program, with the information available to it, has not been able to identify all of the many potentially hazardous trees and stands. This situation prompted the Park to request the present re-evaluation of this problem.

OBSERVATIONS

In our examination of some of the more heavily damaged developed sites we, jointly with the NPS staff, made the following observations and conclusions.

Camp Six - This area, containing employee tent frames, has long been infested with F. annosus, and root disease centers have created large openings in this stand of large-diameter, tall ponderosa pines. This past winter, severe mono winds, coming down canyon, were deflected off the cliffs surrounding the Valley into the Camp Six area and blew over many large trees. An examination of the windthrown trees showed that most of them were sound with little or no decay in the roots. The root systems, however, were extremely small: both shallow and small in diameter. It appears that because of a high water table in this area, which is next to the river, the root systems are only 5 to 6 feet deep. The stand, which has developed as a very dense stand, restricted the diameters or widths of the root systems. Because the high water table provided an abundance of water for growth, these trees grew very large and tall. Developing in a stand with no openings, the individual trees were not exposed to much wind stress. But after the root disease created openings in the stand, these very large trees with their limited root systems growing in a light sandy soil were now exposed to the winds, and the trees on the margins of the centers were windthrown. After a few years of severe winter mono winds, much of Camp Six is now denuded. The surviving stand surrounding these openings is still very hazardous, during high winds, and the Park is in the process of closing the area to high-use activities. Some thought needs to be given to deciding what kind of vegetation should best occupy this site in the future, to avoid a repeat of this incident 60 to 80 years in the future.

Yosemite Lodge Area - This is a very large area containing many expanding and coalescing F. annosus root disease centers. It is also an area densely packed with cabins, apartments, parking lots and other recreation facilities. Here tree failure has been scattered, but because of the dense facilities that serve as targets, considerable damage has been done. During the past winter several cabins and cars were destroyed, and a lodge was damaged by falling trees. Almost all the tree failures were caused by diseased and rotted root systems. We looked at three standing incense-cedars with thin crowns. An examination of their roots showed dead cambium at the root collar just below the soil surface on the side of the tree facing the infection center. Small white flecks or pockets of fungus mycelium could be seen on the inner surface of the bark chip which was removed to expose the dead cambium. Small fruiting bodies (pop-corn conks) of F. annosus were also found on the bark at the root crown. These are good diagnostic signs that F. annosus is present in the roots. The same kind condition - dead cambium at the root crown - was found on another thin-crowned incense-cedar in the front of Alder Cottage. A second thin-crowned incense-cedar in this same area was found with a large F. annosus sporophore under the grass at the root crown. Lorne acknowledged that crown symptoms are a good sign of root decay in incense-cedar, but regretted that there is no similar system available for estimating root decay in

pine. A high proportion of the tree failure and damage in the Lodge area was from failing pines which could not have been identified from crown appearance as having significant root decay and, therefore, a high probabililty of failure. He pointed out that a method of identifying pines with a high probability of failure is a high-priority need of Yosemite NP.

In regards to the Lodge Area in general, there are so many F. annosus centers in the cabin area that it is our conclusion that there is a moderate to high probability that many of the standing trees in the cabin area are already infected, making it just a matter of time before they die or fail. It would seem advisable to close out the cabin area at the earliest opportunity, because the accuracy of our predictive methods or tools is not adequate to identify all hazardous trees. That robs Park personnel of the opportunity to prevent continuation of the currently unpredictable and damaging failure of resident trees.

Muir Picnic Area - Although our maps indicate that there is some F. annosus in this area, all of the considerable tree failure we observed was due to remarkably small root systems, wet sandy soils, and large trees, which were blown over in a wind storm. In falling over, the trees seemed to swivel and turn in the soil as if the root system were a ball in a ball-and-socket joint. There was only a little up-lifting of the back side of the root system and the front side was pushed below grade. There was very limited root support for such large-diameter, tall trees. This area will continue to be quite susceptible to wind throw during periods of high winds. Its use during stormy and windy periods of the year is questionable. If this picnic area is to be used in the distant future, some consideration needs to be given to the type of vegetation which is allowed to replace the failing pine stand, so that this kind of situation does not repeat itself.

Rivers Campgrounds - Some recent root disease-caused mortality had occurred on the margin of known infection centers in these two campgrounds. Only a few trees were involved, but continual tree loss has created some extremely large openings in the campground pine stand and is promising to create some more. Little or no windthrow has recently occurred in these two campgrounds.

Devils Elbow - This picnic area on the edge of the river has a known F. annosus root disease center in it. Lorne questioned if two large thin-crowned ponderosa pines on the margin of this center were infected. We could find no positive indicators that they were infected, other than the thin foliage and some resin soaking in a root. We cored both trees at the root crown and brought the cores back for culturing. In the laboratory we found that these cores from both trees were indeed infected with F. annosus. This technique may be of use to the Park in the future in identifying infected trees. Later this summer we plan to meet with Lorne and test this technique on additional trees which are thought to be infected, but from outward appearance cannot be confirmed as such.

CONCLUSIONS

Hazardous trees and their control are a serious and expensive problem in Yosemite Valley. The program of detecting and preventing tree failures in developed sites in the Valley has been very effective, although it is handicapped by budget constraints and by insufficient technology to identify all weakened and hazardous trees. The Park is concerned and desires to increase the effectiveness of its hazardous tree control program. To do this, the Park will need to consider and implement at least some of the suggested actions we have included in the next section of this report. These actions may be expensive and controversial, for they will result in the following costs:

1. Increased dollar costs and manpower investments for record keeping, detection surveys, tree removal, and evaluation of unexpected failures.

2. Esthetic costs resulting from hazardous tree removal in developed sites with already sparse tree cover, such as in the Lodge Area.

3. The costs of public controversy when sites with highly hazardous conditions are closed, resulting in a decrease in the number of overnight facilities in the Valley.

Although the costs of a program with these actions are very significant, we see no other way of increasing the effectiveness of the hazardous tree control program in the Park.

SUGGESTED ACTIONS

We, the NPS and FS personnel, discussed needs and possible new actions which might be taken to reduce tree failure and tree hazard in the developed sites of the Valley. These actions are discussed below.

A. Surveys and Evaluation.

1. Records. The Park could begin to keep records of tree failures much as Dr. Lee Paine (retired PSW Experiment Station) has done on a National basis. The information contained in these records would allow the Park to better characterize the major causes and conditions leading to failure identify the most hazardous times and places and make and support decisions with sound data rather than impressions. Paine has developed computer systems for doing this, and he may be available for advice.

2. Coring and Culturing - from pines suspected of having Fomes annosus. With the current methods available, the Park is unable to confirm the presence of F. annosus in infected ponderosa pines and incense-cedars until they die or fail. The Park indicated that if they knew a pine were infected, they would remove it from developed sites where it would be potentially hazardous. We tried a new method of examining for the presence of F. annosus on a few trees this spring.

This involved using an increment borer to remove a core of wood at the root crown on the side of the tree facing the infection center. This wood core was placed in a plastic bag, labeled, and later placed on water agar in petri dishes. If the fungus is present in such a wood core, it will produce characteristic sporophores in a week or two. Three pine trees we examined by this method proved to have F. annosus; so the technique has some merit. FPM could assist the Park in making another, larger similar trial and could teach the Park personnel how to do the extraction and culturing.

3. Training - FPM can provide additional training at the request of the Park. Such training could be in the nature of hazard recognition, control, and prevention; culturing for root diseases; or hazard rating.

B. Potential New Treatment Actions. The current hazard program is going about as far as it can to identify and remove recognizable hazardous trees. We talked of other ways the Park might reduce the hazard in a logical manner.

1. Moving the Target - In areas of doubt where the risks are high the Park could relocate the target to a safer area. The Lodge is such an area where the risk of failure and the chances are great that a failing tree would do considerable damage. In this case the Park could reduce the hazard by moving Lodge cabin and apartment facilities to another area.

2. Cutting a Buffer - The 1970's evaluation identified the root root disease infection centers in the Valley's developed recreation sites. It also predicted 10-year increments of spread outward from these centers. In those developed sites where the potential targets are concentrated and/or of high value, and the manager wishes to reduce the probability of failure below that which can be achieved by removal of just those trees recognizably hazardous, the manager could cut all infected trees. This can be accomplished by cutting and removing a buffer of those trees surrounding an infection center which are predicted to die within the next 10 years.

3. Seasonal Closures - The failure of trees in the Park is seasonal, in that most failures occur in the winter during storms. These storms affect different sites more strongly than others, due to site, soil, exposure, and stand factors. For example, Camp Six has been extremely sensitive to winter storms. The Park could identify those sites with a history of high failure during winter storms, close them, and keep open the sites with low winter failure.

Consequences of the New Actions

These new actions would all have some consequences in common. First, the frequency and incidence of accidents due to tree failure would be reduced, by reducing the exposure of targets to hazardous trees, either by removing the targets or by removing the additional trees that have lower probabilities of failure. Second, the expenditures needed for

implementing these new actions would increase the overall costs of the hazardous tree control program. Third, the benefits resulting from the decreased level of damage and injury probably would more than offset this increased cost. (Records kept over a 10- to 20-year period could provide an unequivocal benefit/cost comparison and could measure success of the program.) And fourth, seasonal closures and the moving and removal of targets might reduce the numbers and sizes of the recreational facilities in the Valley and result in some public disappointment.

Those actions suggesting the removal of more trees with lower probabilities of failure would result in more open, safer stands. A program of planting openings with native hardwoods would, in the long term, help to reduce this disadvantage. To be successful, such a planting program would need to be an annual, sustained, serious effort. Periodic trials, for example, would fall short of achieving sought-after results.

Long-Term Planning

Most of the actions we have discussed are short-term (5-30 years). Some thought should be given to the long-term (50+ years) effects and solutions of this problem. We are not sure how or if these pest-hazard problems are considered in the long-range plans of Yosemite NP, but it is our belief that they must not be ignored or overlooked. The pine stand growing in the Valley is approximately 80 years old and is now falling apart due to root disease, bark beetles, site conditions and environmental stress. If a similar even-aged stand of pine establishes itself in place of the current stand, history will most likely repeat itself in another 60-80 years and the Park will be faced with another major hazardous tree problem. On other other hand, long-term planning that includes selecting and managing the replacement vegetation in and around the developed sites, could greatly lower the incidence of tree failure in the future.